	Station	Records made by—	Duration From—	Duration To—	Equipment	Remarks
52	Mexicali, Mexico	Primera Zona de Irrigacion	July 13, 1923	Present	Zinc pan, 1.22 meters, circular, above ground.	Records available at office of Primera Zona de Irrigacion, Mexicali, Mexico.
53	Bard	Bureau of Plant Industry	1910	do	Tank, 30 inches by 6 feet, circular, embedded in ground.	See published reports of the work of the Yuma experiment farm.
54	Yuma, Ariz	University of Arizona and Weather Bureau.	July 1, 1917	do	Class A, Weather Bureau standard	Published in Climatological Data—Arizona Section.
55	Yuma, Ariz. (near)	do	September, 1920	do	do	Do.
56	San Luis Rey Valley	Geological Survey	1914	1915	Entire valley considered as an evaporation pan.	See Water Supply Paper No. 446, United States Geological Survey (1919).
57	Lake Hodges Dam	San Dieguite Mutual Water Co	1914	Present	Pan, 18 inches by 3 feet, square, set 12 inches into ground.	Now under control of City of San Diego, Calif.
58	Cuyamaca Reservoir	Cuyamaca Water Co	1913	do	Pan, 18 inches by 3 feet, square, set 16 inches into ground.	Records available at office of La Mesa, Lemon Grove and Spring Valley irrigation district, La Mesa, Calif.
59	Murray Reservoir	do	1912	January, 1928	Floating pan, 18 inches by 3 feet, square, submerged 12 inches.	Do.
60	Sweetwater Dam	Sweetwater Water Corporation	1889	1919	Floating pan, 18 inches by 3 feet, square.	Summary available at company office, National City, Calif.
61	Chula Vista	Western Salt Works and Weather Bureau.	Sept. 1, 1918	Present	Class A, Weather Bureau standard.	Published in Climatological Data—California Section.
62	Morena Dam	City of San Diego	November, 1915	do	Floating pan, 18 inches by 3 feet, square, submerged 16 inches.	Records in operating department, city hall, San Diego, Calif.
	do	do	August, 1925	do	Pan, 18 inches by 3 feet, square, embedded in ground.	Do.
63	Barrett Dam	do	August, 1923	do	Floating pan, 18 inches by 3 feet, square, submerged 16 inches.	Do.
	do	do	August, 1925	do	Pan, 18 inches by 3 feet, square, embedded in ground.	Do.
64	Upper Otay Dam	do	April, 1916	July, 1921	Floating pan, 18 inches by 3 feet, square, submerged 16 inches.	Do.
	do	do	August, 1925	Present	Pan, 18 inches by 3 feet, square, embedded in ground.	Do.
65	Lower Otay Dam	do	November, 1915; August, 1920	December, 1915; Present	Floating pan, 18 inches by 3 feet, square, submerged 16 inches.	Do.
	do	do	August, 1925	do	Pan, 18 inches by 3 feet, square, embedded in ground.	Do.

551.590.2 : 551.510.4

NOTES, ABSTRACTS, AND REVIEWS

Anders Ångström on the atmospheric transmission of sun radiation and on dust in the air,[1] *by H. H. Kimball.*—The author remarks that the overwhelming interest of Smithsonian Institution investigators in variations in the solar output of radiant energy is perhaps responsible for the comparatively slight use that has been made of their valuable data on atmospheric transmission in detailed studies of the way in which the atmosphere acts on the radiation that penetrates it. For example, during the years 1923–1928, while the range from minimum to maximum in the annual mean values of the solar constant has been only about 0.5 per cent, the range in corresponding annual amounts of solar radiation reaching the surface of the earth at Stockholm has been 25 per cent.

Three general ways in which the atmosphere depletes radiant energy passing through it are given as follows:

(1) Selective absorption by the gases of the atmosphere.
(2) The scattering or diffusing effect of the atmosphere.
(3) The scattering by atmospheric dust.

The loss by reflection from cloud surfaces is not here considered.

The major part of the loss by selective absorption is due to the absorption in the infra-red part of the spectrum by water vapor, the relation of which to surface water-vapor pressure has been determined by Fowle. Likewise, the scattering by gas molecules may be computed by means of Rayleigh's equations as modified by King.

The law of the scattering of radiant energy by atmospheric dust is not so well known. The expression for scattering by gas molecules contains the expression $\frac{1}{\lambda^4}$, where λ is the wave length of the radiant energy. It has generally been assumed that scattering by dust is independent of the wave length, but since dust particles vary greatly in size, Ångström concludes that in the expression for scattering by dust the exponent of λ must be greater than 0 and less than 4, and that the scattering may be expressed by $\gamma = \frac{\beta}{\lambda^a}$.

From computed values of the transmission for dust-free air for wave lengths free from selective absorption, and observed values of the transmission at different places for the same wave lengths, Ångström computed the values of a and β given in Table 1.

TABLE 1.—*Data on scattering of solar radiation by dust*

Stations	Altitude above sea-level	Average conditions β	Average conditions a	Haziest days for August, 1921 β	Haziest days for August, 1921 a	Authority
	Meters					
Washington	35	0.098	1.24			Smithsonian Institution.
Upsala	35	(.090)	(.70)	0.362	0.515	Lindholm, 1912.
Bassour	1,160	.031	1.22	.255	.53	Smithsonian Institution.
Hump Mountain	1,500	.031	1.33			Do.
Mount Wilson	1,780	.018	1.26	.205	.70	Do.
Calama	2,250	.023	1.33			Do.

The author points out that β is the scattering by dust for radiation at $\lambda = 1$ micron without regard to the value of a. Also, if the depletion due to scattering by dust were independent of λ, a should equal zero. Actually, however, Table 1 shows that under average conditions a varies but little from 1.28 over a wide geographical range, and at widely different altitudes, and that the haze caused by the eruption of Katmai Volcano in June, 1912, increased the value of β about tenfold, and greatly reduced the value of a.

From the values of a in Table 1 it appears that the size of the dust particles is independent of height above

[1] Geografiska Annaler 1929, H. 2.

sea level. This is contrary to measurements of the diameters of dust particles collected by means of an Owens dust counter by Mr. Hand during airplane flights up to 10,000 feet. It must be remembered, however, that in general such dust as is present in the atmosphere at a place like Calama, Chile, for example, is principally of local surface origin, and should not differ in size from surface dust at sea level.

Ångström's determinations fix the average diameter of atmospheric dust particles under normal conditions at about 1 micron, and indicate a considerable increase in diameter in August, 1912, when the source of the dust was principally the explosive eruption of Katmai Volcano in Alaska. From the width and angular dimensions of Bishop's ring, which has been shown to result from the diffraction of light by volcanic dust, the diameter of these dust particles has been computed to be 1.85 microns.

Ångström also finds that the variation in the value of β with height may be expressed by the equation $\beta_h = \beta_0 \, e^{-\delta \times h}$ where $\delta = 0.69 \times 10^{-5}$; and, similarly, that the vertical variation in the number of atmospheric dust particles, as determined by Hand's measurements, may be expressed by the equation $N_h = N_o \, e^{-\phi \times h}$, where $\phi = 0.7 \times 10^{-5}$. It will be noted that the exponent of e in the two equations is practically the same.

Adopting for β_0 and N_o the values 0.094 and 400, respectively, or approximately the mean of their respective values for Washington and Upsala, Ångström derives for Σ N, the number of particles in a vertical column 1 square centimeter in cross section, the value 5.6×10^7 He also derives the general expression $\beta = 1.79 \times 10^{-9} \, \Sigma \, N$. From this latter the monthly mean values of β have been computed for Washington. They show a marked annual variation, with a maximum of 0.157 in May and a minimum value of 0.051 in November and December. As the author states, this does not agree with the annual variation in the number of dust particles found at the surface; but when we consider the probable value of the monthly means of Σ N we must take into account the difference in vertical distribution found by airplane measurements in August and November. Therefore, since convection is most active in late spring and early summer, and least active in late fall and early winter, there is nothing incongruous in the annual variation of β.

Summarizing, a more accurate way seems to have been found for computing the solar-spectrum energy distribution at the bottom of the atmosphere, except in the ultra-violet, where actual measurements are required. Also, the size of the dust particles as indicated by the value of α should be a clue to their source. For example, dust particles of volcanic origin appear to be larger than dust particles from the surface of the ground, while cosmical dust particles, which are thought to have been observed at times of sunspot maxima, probably are smaller. 551.524 (048) (215-17)

Temperature distribution up to 25 kilometers over the Northern Hemisphere.—K. R. Ramanathan, meteorological department, Poona, India, has published in Nature (London), June 1, 1929, a very interesting chart showing the distribution of temperature up to 25 kilometers over the Northern Hemisphere for summer and winter. (Fig. 1.) The broken lines (except that for 0° C.), the author states:

Are based on very few observations, and are therefore mainly conjectural. The principal features of the diagram may be briefly summarized.

(1) The stratosphere is not isothermal over any particular place, but above a certain level there is a tendency for the temperature to increase with height.

(2) The coldest air over the earth, of temperature about 185° A., lies at a height of some 17 geodynamic kilometers[1] over the Equator in the form of a flat ring surrounded by rings of warmer air.

(3) The surface of the tropopause has a relatively steep slope toward the pole between latitudes 30° and 50° in summer and between 25° and 45° in winter

(4) The ring of lowest temperature at the tropopause is displaced toward the summer hemisphere.

(5) There is a ridge of high temperature in the tropopause between latitudes 20° and 40° north in summer corresponding to the ridge of high pressure at 8 kilometers over those latitudes. (See Sir Napier Shaw's chart of 8 kilometers isobars in July, Manual of Meteorology, vol. 2, p. 262.)

A comparison of this chart has been made (by the reviewer) with the results of some recent aerological observations made in this country which were not included in the data comprising the chart. The average height and temperature of the tropopause as determined from a sounding balloon series made at Royal Center, Ind., in May, 1926, and at Groesbeck, Tex., in October, 1927, are

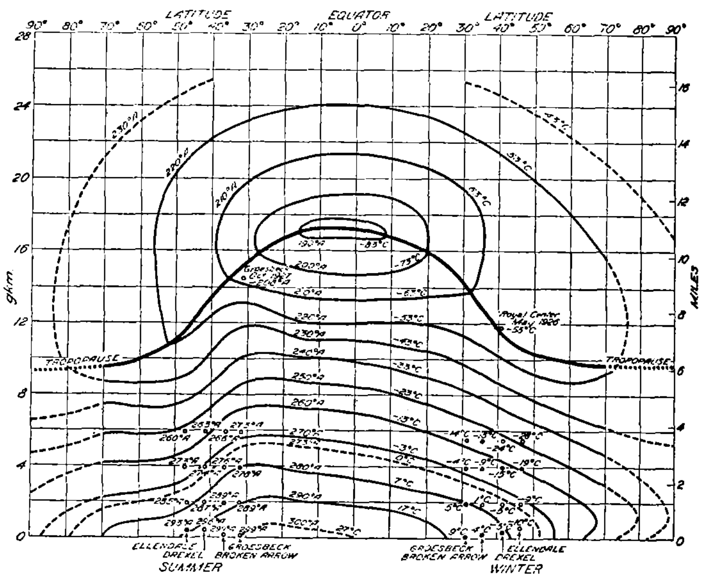

FIGURE 1.—Distribution of temperature up to 25 kilometers over the Northern Hemisphere

found to be in close agreement with the data depicted. These values are indicated at the corresponding points on the chart.

There are also indicated for comparison purposes the average temperatures at various heights as determined for summer and winter from kite observations made at four aerological stations in the United States, viz., Ellendale, N. Dak., latitude 45° 59′; Drexel, Nebr., latitude 41° 20′; Broken Arrow, Okla., latitude 36° 02′, and Groesbeck, Tex., latitude 31° 30′. While all of the latter do not coincide with the smoothed isotherms of the diagram, the general agreement is good, and the differences found are undoubtedly real and due to the greater extremes in temperature found in continental United States as compared to Europe.—*L. T. Samuels* 546.214 (048)

How high is the ozone layer?—By Charles Fitzhugh Talman.—For many years it has been known that a relatively large amount of ozone is present at high levels

[1] The following quotation from Manual of Meteorology, Volume 2, p. xx, by Sir Napier Shaw, will explain what is meant by geodynamic kilometers: "There is a good deal of laxity about the use of the word height, of the same kind as that of the aeronauts who graduate a pressure instrument to read what they call height. For example, V. Bjerknes and others would express the height of a point in the atmosphere by the geopotential at the point, calling the quantity expressed the dynamic height. We reproduce from the *Avant Propos* of the *Comptes rendus des jours internationaux*, 1923: 'The relation of the geopotential at any position to the geometric height of that position h and the gravitational acceleration g is $\Gamma = \int g dh$. The value is governed accordingly by the local value of gravity depending on the attraction of gravitation and the rotation of the earth, but not to any appreciable extent upon the condition of the atmosphere at the time of observation.'"